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PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY


(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

REC'D 28 OCT 2005

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Applicant's or agent's file reference XA1794		FOR FURTHER ACTION		See Form PCT/PEA/416
International application No. PCT/GB2004/002805		International filing date (day/month/year) 29.06.2004	Priority date (day/month/year) 01.07.2003	
International Patent Classification (IPC) or national classification and IPC G01T3/08				
Applicant BAE SYSTEMS PLC				
<p>1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 6 sheets, including this cover sheet.</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <p>a. <input checked="" type="checkbox"/> sent to the applicant and to the International Bureau a total of 4 sheets, as follows:</p> <p><input type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).</p> <p><input type="checkbox"/> sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.</p> <p>b. <input type="checkbox"/> (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).</p>				
<p>4. This report contains indications relating to the following items:</p> <p><input checked="" type="checkbox"/> Box No. I Basis of the opinion</p> <p><input type="checkbox"/> Box No. II Priority</p> <p><input type="checkbox"/> Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p><input checked="" type="checkbox"/> Box No. IV Lack of unity of invention</p> <p><input checked="" type="checkbox"/> Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p><input type="checkbox"/> Box No. VI Certain documents cited</p> <p><input type="checkbox"/> Box No. VII Certain defects in the international application</p> <p><input checked="" type="checkbox"/> Box No. VIII Certain observations on the international application</p>				
Date of submission of the demand 21.02.2005		Date of completion of this report 31.10.2005		
Name and mailing address of the international preliminary examining authority:  European Patent Office - P.B. 5818 Patentlaan 2 NL-2280 HV Rijswijk - Pays Bas Tel. +31 70 340 - 2040 Tx: 31 651 epo nl Fax: +31 70 340 - 3016		Authorized Officer Datta, S Telephone No. +31 70 340-3172		



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Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
- ☐ international search (under Rules 12.3 and 23.1(b))
 - ☐ publication of the international application (under Rule 12.4)
 - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

Description, Pages

1-12 as originally filed

Claims, Numbers

1-25 received on 17.02.2005 with letter of 17.02.2005

Drawings, Sheets

1/3-3/3 as originally filed

- ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing
3. ☐ The amendments have resulted in the cancellation of:
- ☐ the description, pages
 - ☐ the claims, Nos.
 - ☐ the drawings, sheets/figs
 - ☐ the sequence listing (*specify*):
 - ☐ any table(s) related to sequence listing (*specify*):
4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
- ☐ the description, pages
 - ☐ the claims, Nos.
 - ☐ the drawings, sheets/figs
 - ☐ the sequence listing (*specify*):
 - ☐ any table(s) related to sequence listing (*specify*):

* If item 4 applies, some or all of these sheets may be marked "superseded."

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Box No. IV Lack of unity of invention

1. ☒ In response to the invitation to restrict or pay additional fees, the applicant has:
- ☒ restricted the claims.
 - ☐ paid additional fees.
 - ☐ paid additional fees under protest.
 - ☐ neither restricted nor paid additional fees.
2. ☐ This Authority found that the requirement of unity of invention is not complied with and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.
3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is
- ☐ complied with.
 - ☐ not complied with for the following reasons:
4. Consequently, this report has been established in respect of the following parts of the international application:
- ☒ all parts.
 - ☐ the parts relating to claims Nos. .

Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	1-25
	No: Claims	
Inventive step (IS)	Yes: Claims	1-25
	No: Claims	
Industrial applicability (IA)	Yes: Claims	1-25
	No: Claims	

2. Citations and explanations (Rule 70.7):

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

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Re Item V

**Reasoned statement with regard to novelty, inventive step or industrial applicability;
citations and explanations supporting such statement**

- 1) Reference is made to the following document/s/:
D1: US-A-5 399 863 (CARRON NEAL J ET AL) 21 March 1995 (1995-03-21)
D2: US-A-5 940 460 (RUDDY FRANK H ET AL) 17 August 1999 (1999-08-17)
- 2) The document D1 is regarded as being the closest prior art to the subject-matter of **claim 1** and shows (the references in parentheses applying to this document):

A neutron detector (Fig1;10) combined with a solid state device in an array (Fig1;12), associated neutron capture material (Fig1;11), which emits particle radiation when irradiated with neutrons. The solid state device then provides an electrical output signal that is indicative of free neutrons (col3 lines 61-68 & Fig 2).

- 3) The subject-matter of **claim 1** differs from that of document D1 in that the concentration of the capture material per unit length varies across the sensor array.
- 4) In view of the above technical features being absent from document D1, it is apparent that the subject-matter of **claim 1** is therefore novel (Article 33(2) PCT).
- 5) The problem to be solved by the present invention may be regarded as:
how to construct a neutron detector which is sensitive to a large dynamic range of

neutron energies.

- 6) The solution to this problem proposed in **claim 1** of the present application is considered as involving an inventive step (Article 33(3) PCT) because providing a capture material with a varying concentration per unit length across the detector array to obtain a variable neutron sensitivity response is neither suggested nor made obvious by the known prior art.
- 7) **Claims 2-22** are dependent claims and as such also meet the requirements of the PCT with respect to novelty and inventive step.

Re Item VIII

Certain observations on the international application

- 8) Dependent **claims 23-25** are unclear since the capture material is stated as being sensitive to X-rays. However, the same claims are dependent on claims that refer exclusively to capture material for neutrons. It is not clear how two very different types of radiation can be converted by the same capture material (Article 6 PCT).
- 9) Multiple Dependent Claims:

The dependency of claims **6,7,9,10,15-23** have been incorrectly formulated since a dependent claim which refers to more than one other claim should refer to them

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only alternatively. Multiple dependent claims cannot form a basis for other multiple dependent claims (PCT/GL/ISPE/1 Ch 5, A5.16(1)).

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CLAIMS

1. A neutron detector comprising the combination of a solid state device having a plurality of sensing elements arranged in a distributed array,
5 each sensing element having an electrical characteristic which changes in the presence of charged particles or electromagnetic radiation, and a neutron capture material which is associated with the solid state device and which has the property that it emits particles or radiation to which the sensing element or elements of the solid state device are
10 responsive when free neutrons are incident upon it such that the solid state device provides an electrical output indicative of incident free neutrons, wherein the concentration of the capture material per unit length or unit area varies across the array of sensing elements to yield a sensitivity variation between different parts of the array.
- 15 2. A detector according to claim 1, wherein the capture material is incorporated in a capture layer overlying the sensing elements of the solid state device.
3. A detector according to claim 2, wherein the capture material is in contact with the sensing elements.
- 20 4. A detector according to claim 3, wherein the solid state device is a charge coupled device (CCD).
5. A detector according to claim 3, wherein the solid state device is an active pixel sensor (APS).
- 25 6. A device according to any of claims 1, 4 or 5, wherein the capture material is a doping material incorporated in the sensing element or elements of the solid state device.
7. A detector according to any preceding claim, including a radiation filter element overlying the said combination, the radiation filter comprising radiation filtering material.

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8. A detector according to claim 8, wherein the filter element is constructed as a filter layer in which the amount of the radiation filtering material per unit length or unit area varies across the layer.
- 5 9. A detector according to any preceding claim, including a shield positioned over the sensing element or elements so as substantially to exclude radiation of a kind other than the said second kind.
- 10 10. A detector according to any preceding claim for detecting free neutron radiation, wherein the capture material has the property that free neutron radiation incident upon it causes it to emit charged particles and the sensing element or elements are responsive to the emitted charged particles.
11. A device according to claim 10, wherein the capture material includes boron-10.
- 15 12. A detector according to claim 11, including a capture element in the form of a layer of a boron-10 enriched borate.
13. A detector according to claim 10, wherein the capture material includes helium-3.
14. A detector according to claim 13, including a capture element in the form of a layer of a solid matrix containing bubbles of helium-3 gas.
- 20 15. A detector according to any of claims 10 to 14 which is sensitive to incident free neutrons with energies in the region of 0.025eV but substantially insensitive to incident free neutrons with energies above 0.5eV.
- 25 16. A detector according to any of claims 10 to 15, wherein the solid state device has a distributed array of sensing cells and, overlying the sensing cells and the capture material, a filter layer made of a neutron energy discriminating material selected to admit through the filter layer only neutrons having various energies, the thickness of the layer varying across the array of sensing cells to yield an energy spectrum sensitive profile for the detector.
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17. A detector according to any of claims 10 to 14, including a neutron moderator layer over the solid state device and the capture material, the moderator layer being formed of a material which reduces the energy of free neutrons passing through the layer, whereby the detector is sensitive to incident free neutrons with energies higher than 0.5eV.
18. A detector according to any preceding claim, including a discriminator coupled to an output of the solid state device, the discriminator selecting only electrical signals received from the output with an amplitude greater than a predetermined value.
19. A detector according to any preceding claim, including means for integrating an output of the solid state device over time to produce a radiation dose reading.
20. A detector according to any preceding claim, including a plurality of different capture elements including a capture material or materials, and a capture element carrier member carrying the capture elements, wherein the carrier member and the solid state device are positioned with respect to each other and moveable relative to each other such that different capture elements may be brought into juxtaposition with the sensing element or elements of the solid state device for the purpose of selecting different detector characteristics.
21. A detector according to any preceding claim, including a plurality of different filter elements and a filter carrier member carrying the filter elements, wherein the filter carrier member and the solid state device are movable relative to each other such that different filter elements may be brought into juxtaposition with the sensing element or elements of the solid device for the purpose of selecting different filter characteristics.
22. A detector according to any preceding claim, including a plurality of different shield members having different shielding characteristics which are selectively locatable to shield the capture material thereby

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substantially to exclude different kinds of unwanted radiation according to which shield member is selected.

23. A detector according to any of claims 1 to 9 or 18 to 22, wherein the capture material has the property that x-rays incident upon it to cause it to emit radiation to which the sensing element or elements are sensitive.

24. A detector according to claim 23, wherein the capture material has the property of emitting photons when x-rays are incident upon it.

25. A detector according to claim 24, wherein the capture material includes zinc sulphide.